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GROWTH CONVERGENCE AND CONVERGENCE CLUBS IN SAARC

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Abstract

We test for output convergence during 1960 – 2014 amongst the leading member countries of the South Asian Association for Regional Cooperation (SAARC): Bangladesh, India, Nepal, Pakistan and Sri Lanka. The context is SAARC's commitment to eventual monetary union. We test for stationarity of relative per capita output by applying established unit root tests. The results do not support the convergence hypothesis, even when structural breaks are permitted. We then use two more recently developed approaches, both of which introduce some flexibility in the depiction of convergence. The method developed by Enders and Lee (2011) allows for a smoothly evolving trend rather than a (possibly breaking) linear trend. The technique introduced by Phillips and Sul (2007, 2009) allows for the possibility of convergent sub-groups. Even with these more flexible test procedures, there is minimal evidence of growth convergence within the full SAARC membership. We find some empirical grounds for arguing that the countries considered can be allocated to two non-overlapping convergence clubs, with India and Sri Lanka enjoying a more favourable growth path than do the other member countries. This finding raises questions regarding the current feasibility of monetary union for SAARC.

Keywords: SAARC; Growth convergence; Convergence clubs

JEL codes: O47

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1. Introduction

The South Asian Association for Regional Cooperation (SAARC) grouping of eight member nations[1] hosts some 23 percent of the world's population but contributes only about 2 percent to world output. In the context of this evident opportunity for economic development, SAARC was established in 1985, with the aim of promoting mutual interests through collaboration in economic, social, cultural, technical and scientific fields. On an economic front, collaboration has evolved to include the SAARC Preferential Trading Agreement (SAPTA), established in 1995, and the South Asian Free Trade Area (SAFTA), established in 2006. SAFTA was intended as a first step along a road to a more complete economic union; the commitment to full economic and monetary union was reiterated at the 18th SAARC summit in 2014. In this paper we assess the extent to which SAARC nations are achieving a convergence in per capita GDP ("growth convergence") that will facilitate eventual monetary union

Previous Studies

Numerous existing studies examine growth convergence for various country groupings, using various methods of assessment. Here we discuss only some selected studies that have focussed on the SAARC countries, beginning with a brief overview of the methods that have been employed.

Barro & Salai-Martin (1992; 2004, Ch.2) show that a log-linear approximation of the neoclassical growth model around its steady state implies a relationship between growth experienced during elapsed time (T) and initial per capita output, viz: $(y_T - y_0)/T = \alpha(T) - \beta(T)y_0$, where y is the natural logarithm of per capita output. The parameters $\alpha(T)$, $\beta(T)$ vary according to the duration of elapsed time. Asymptotically, $\beta(T) \to 0$ and $\alpha(T) \to g$, an exogenously given rate of technological progress that provides a steady state growth path towards which the neoclassical growth model converges. In any finite period of time, $\beta(T) > 0$, implying a negative relationship between growth achieved during that period and the initial per capita output level. Where a group of countries are assumed to have similar fundamental parameters this model predicts that the countries which are initially poorer will experience more growth – a "catching up" hypothesis that is labelled "β-convergence". In empirical studies based on cross-sectional data the period of elapsed time (T) may be many

[1] Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka.

years; studies using time series or panel data typically employ $T = 1$ so that a test regression, with disturbance term ε_t, is $\Delta y_t = \alpha - \beta y_{t-1} + \varepsilon_t$. This basic regression is often augmented with additional regressors to measure other influences on the current growth rate and in this case a statistically significant estimate for β is said to imply "conditional β-convergence" – a situation in which steady state growth paths may differ between countries. If the time path for the additional regressors can be adequately proxied by a (possibly non-linear) time trend then the test equation becomes $\Delta y_t = \alpha - \beta y_{t-1} + trend_t + \varepsilon_t$, inviting unit root testing as an approach to detecting the presence of convergence. Rejection of the unit root null hypothesis, $H_0: \beta = 0$ in favour of $H_A: -\beta < 0$ is evidence of convergence to steady state. If y_t is replaced by *relative* log per capita income: $\tilde{y}_t = y_t - y_t^*$, where y_t^* is some reference level for log per capita income, such as the logarithm of average per capita income within some relevant group of economies (Carlino and Mills, 1993), then rejection of a unit root constitutes "stochastic convergence" (Li and Papell, 1999). Stochastic convergence within a group of countries does not imply eventual full convergence of per capita output levels unless the deterministic component, $\alpha + trend_t$, also converges on, zero – "deterministic convergence". A group of countries that are assessed as converging on a common growth path, can be expected to also exhibit "σ-convergence" – a diminishing cross-sectional range of variation. A rigorous approach to testing for a long-run diminishing trend in cross-sectional variance has been developed by Phillips and Sul (2007, 2009).

Turning now to existing studies focussed on the SAARC countries, Chowdhury (2004) investigated convergence of per capita GDP, using data for 1960 – 2000, finding no evidence of σ-convergence or β-convergence or conditional β-convergence. Evans and Kim (2005) estimated a random coefficients variant of a neoclassical growth model for a panel of 17 Asian countries over the period 1960-1992. Their panel included Bangladesh, India, Pakistan and Sri Lanka from the SAARC countries. They found that the estimated mean for the random coefficient on lagged per capita output was negative and significantly different from zero, as is required for β-convergence. After applying a shrinkage estimator they additionally concluded in favour of country-specific β-convergence for Bangladesh, Pakistan and Sri Lanka, but not India, from amongst the SAARC Countries. They did not find evidence of convergence to a common growth path. Evans and Kim (2011) assessed stochastic convergence in a panel of 13 Asian countries, including the four SAARC countries assessed in their 2005 study, and with the USA providing a reference level of per capita income. They employed the Carrion-i-Silvestre *et al.,* (2005) panel stationarity test, which extends the

KPSS[2]-based test of Hadri (2000) to allow for multiple country-specific structural breaks. When allowing for cross-sectional interdependence they concluded in favour of stationarity for the panel, implying stochastic convergence for the panel overall. KPSS stationarity tests for the individual countries did not find stationarity in all cases: stochastic convergence was found for Bangladesh, Pakistan and Sri Lanka, but not for India. The test equations included intercepts and time trends so that the discovered stochastic convergence cannot be taken to imply deterministic convergence. Jayanthakumaran and Lee (2013) investigated growth convergence for 5 countries from each of the SAARC and ASEAN (Association of South East Asian Nations) groupings. They looked for stochastic convergence within each of these groupings using each group's mean per capita income as the reference level. They employed the Lumsdaine and Papell (1997) unit root test, which allows for two endogenously determined break dates under the alternative hypothesis of (broken) trend stationary. They concluded in favour of stochastic convergence for the ASEAN countries but not for the SAARC group, where their data covered 1973 - 2005. Solarin et al. (2014) have also investigated income convergence in the SAARC and ASEAN groupings for data covering 1970 – 2009. Sourcing their data from Penn World Tables (7.0) allows them to include all SAARC countries in their investigation. Employing the Lee and Strazicich (2003) unit root test, with two endogenously dated breaks under both null and alternative hypotheses, they find that only Bhutan shows evidence of stochastic convergence to the group mean.

Plan of the paper

The overall conclusion from existing investigations of growth convergence within SAARC is that these have provided some support for a convergence hypothesis but the evidence is slight, is not always confirmed at the individual country level, and when it exists may be limited to "stochastic convergence" – convergence upon a stable set of relative income levels that may not imply eventual equality between countries. These studies prompt two questions worth investigating: (i) whether evidence for convergence might be discovered by testing procedures that permit more flexibility in the specification of structural breaks, and (ii) whether evidence of convergence might exist for some subset(s) of the SAARC countries. These two questions are addressed below using data covering 1960 – 2014..

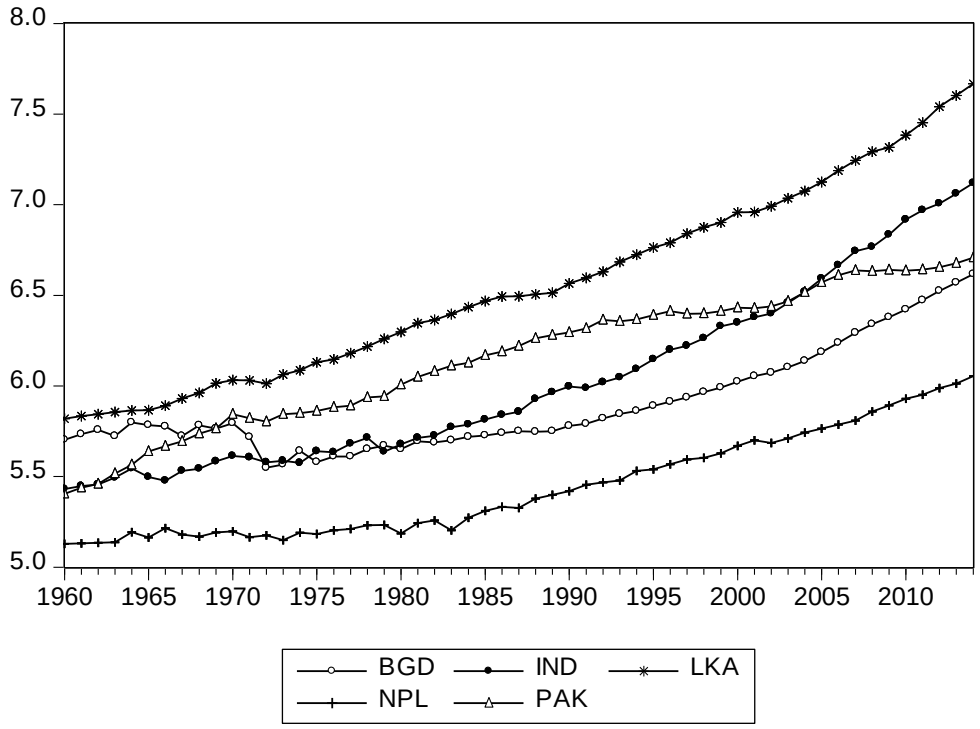
The paper continues with an introduction to the data in section 2, various convergence tests for the SAARC5 group in section 3, a search for convergent sub-groups in section 4, and conclusions in section 5.

[2] Kwiatkowski, Phillips, Schmidt and Shin (1992)

2. Data

The key variable for this study is the logarithm of real per capita GDP, in 2005 $US, observed annually from 1960 until 2014, and graphed in Figure 1.

Figure 1: log per capita GDP, 2005$US, SAARC5 members



The data are sourced from the World Development Indicators[3] (WDI) website of the World Bank. The countries studied: Bangladesh (BGD), India (IND), Sri Lanka (LKA), Nepal (NPL), and Pakistan (PAK) are referred to here as the SAARC5 group. Afghanistan, Bhutan and the Maldives, which have been excluded from the study because of the shortness of their GDP data series, together contribute less than 1% of total SAARC GDP in the years where their data are available. Real per capita GDP for the SAARC5 group overall is constructed by aggregating the GDP and population data for the individual countries.

[3] http://data.worldbank.org/data-catalog/world-development-indicators

3. Assessing Stochastic Convergence with Unit Root Tests

We utilise increasingly less restrictive depictions of stochastic convergence. Our starting point is the Carlino and Mills (1993) depiction of stochastic convergence as stationarity of country-specific per-capita income levels relative to the group mean. Applying the familiar ADF test equation to $\{\tilde{y}_{i,t} = y_{i,t} - y_{s,t}\}$ the series of differences between the i[th] country's own (log) per capita GDP, $y_{i,t}$, and that of the SAARC5 group overall, $y_{s,t}$, we do not reject the unit root null hypothesis for any of the SAARC5 countries. This lack of support for stochastic convergence is found at significance levels considerably above 10%, whether or not a trend term is included in the test equation (see Table 1).

Table1: ADF tests on log relative per capita GDP

	with trend		with constant only	
	t-stat.	prob.	t-stat.	prob.
BGD	-1.985	0.5943	-1.895	0.3320
IND	-1.398	0.8506	+1.121	0.9972
LKA	-1.489	0.8212	-1.337	0.6058
NPL	-0.498	0.9806	+1.628	0.9994
PAK	-0.185	0.9919	+0.670	0.9904

Note: lag length determined by AIC

By way of confirmatory analysis we additionally employ the KPSS test, which has stationarity as the null hypothesis. This test rejects stochastic convergence for each country, in all cases with p-values below 10%, and below 5% if a trend is permitted (See Table 2).

Table 2: KPSS LM test statistics for log relative per capita GDP

	with trend	with constant only
BGD	LM = 0.185 **	LM = 0.864 ***
IND	LM = 0.253 ***	LM = 0.728 **
LKA	LM = 0.220 ***	LM = 0.666 **
NPL	LM = 0.200 **	LM = 0.851 ***
PAK	LM = 0.263 ***	LM = 0.403 *

Notes: Bartlett kernel; Newey-West bandwidth
; *, **, *** indicate rejection of the null at significance levels
of 10%, 5%, 1%, respectively

Perron (1989) has argued that under-rejection of a unit root null can occur when series are stationary around a broken trend but the breaks are not incorporated into the test equation. To explore the possibility of broken-trend stationarity, we applied the Bai-Perron (1998) multiple breakpoints test to a non-augmented Dickey-Fuller test equation in which trend and intercept coefficients were permitted to have change-points. Sequential testing of L+1 vs. L

breaks at a 5% significance level estimated the number of breaks as: BGD=2, IND=1, LKA=1, NPL=1, PAK=0 (See Table 3).

Table 3: Bai-Perron estimates of number of trend breaks in DF test equation for log relative per capita GDP

BGD	2	From sequential testing of L+1 vs. L breaks at 5% significance with Eviews defaults for maximum breaks and trimming
IND	1	
LKA	1	
NPL	1	
PAK	0	

With this in mind we apply the Zivot and Andrews (1992) and the Lumsdaine and Papell (1997) tests to each country's relative log per capita GDP series, $\{\tilde{y}_{i,t}\}$. These unit-root tests permit, respectively, a single break or two breaks in the intercept and trend coefficients under the alternative hypothesis of (broken) trend stationarity, with the break dates being data-determined. When a single break is permitted, only India and Sri Lanka offer some evidence of stochastic convergence, rejecting a unit root at significance levels marginally above 10%[4], in favour of broken-trend stationarity (See Table 4).

Table 4: Zivot and Andrews test for unit root vs. break in intercept and trend

	BGD	IND	LKA	NPL	PAK
t-stat	-3.988	-4.727	-4.801	-4.190	-2.508
Lags	7	0	0	2	0
Break	1975	1979	1979	2000	1979

Note: Asymptotic critical values at 10%, 5%, 1% significance: -4.82, -5.08, -5.57

Permitting two breaks under the alternative ("stochastic convergence") hypothesis increases, as might be expected, the number of countries for which the unit root null is rejected at a significance level close to 10% (See Table 5). There is however, little consistency with the one-break case regarding either the countries for which stochastic convergence is identified or the estimated break dates.

[4] Quadratic interpolation of the 1%, 5%, 10% asymptotic critical values gives approximate p-values of 10.4% for Sri Lanka and 12.3% For India.

Table 5: Lumsdaine and Papell test for unit root vs. two breaks in intercept and trend

	BGD	IND	LKA	NPL	PAK
t-stat	-6.535	-6.192	-5.049	-6.896	-3.774
lags	8	8	4	9	5
break 1	1967	1991	1971	1968	1991
break 2	1972	2005	1979	2003	2005

Note: asymptotic critical values at 10%, 5%, 1% significance: -6.49, -6.82, -7.34

One criticism of tests that, as above, employ segmented linear trends is that a small number of instantaneous breaks in trend may not be best suited to representing the progress of developing economies. Enders and Lee (2011) offers a Lagrange Multiplier (LM) unit root testing framework in which sine and cosine terms provide a flexible non-linear trend, able to approximate structural breaks of unknown number and dates. They propose that, where the breaks are not too many in number or too extreme in magnitude, then a single trigonometric frequency, selected on a "best-fit" basis, can suffice. They provide critical values for a choice of single frequency from $k = 1$ to $k = 5$. They advise pre-testing the null hypothesis of linearity and applying some alternative test with linear trend when linearity ($k = 0$) is not rejected. We follow this advice by employing the Schmidt and Phillips (1992) LM test with a linear trend when linearity is not rejected at a 10% significance level. Table 6 shows the results of applying this approach. The test equation is augmented with lagged terms as suggested by Enders and Lee (2011) with the lag length here determined by the rule: "long enough so that residual autocorrelation is absent and an additional lag would not improve the AIC."

Table 6: Unit root testing on log relative per capita GDP with flexible trends

country	k	t-stat	5% cv	10% cv	lags
BGD	0	-2.294	-3.04	-2.76	1
IND	1	-3.688	-4.11	-3.83	0
LKA	0	-1.522	-3.04	-2.76	0
NPL	1	-4.627	-4.11	-3.83	0
PAK	1	-2.250	-4.11	-3.83	1

Note: critical values are extrapolated from Enders and Lee (2011, table 1) and Schmidt and Phillips (1992, table1a)

It is apparent in Table 6 that, even with this very flexible trend specification, the unit root null hypothesis is rejected, at a 5% significance level, only for Nepal. We conclude that the SAARC5 group as a whole is not showing evidence of even "stochastic convergence", i.e. trend-stationarity in each country's log per capita GDP relative to the group average. This

result questions the feasibility of SAARC-wide monetary union in the near future. Nevertheless, it is possible that some sub-group(s) of countries might show evidence of mutual convergence – a question to which we now turn.

4. Searching for convergence clubs

A sub-group of mutually convergent countries is commonly called a "convergence club". We explore this possibility first by looking for instances of stationarity in bilateral relative (log) per capita GDP: $\tilde{y}_{ij,t} = y_{i,t} - y_{j,t}$. We use the Enders & Lee (2011) procedure, as described above, to flexibly accommodate whatever non-linearities might be present in the trend for such bilateral relativities. Table 7 shows that all countries are involved in at least one country pair where the unit-root null is rejected at a significance level of 10% or only marginally above this, suggesting that the possibility of some convergence club(s) should not be ruled out without further investigation.

Table 7: Flexible trend unit root testing for bilateral differences in log per capita GDP

country 1	country 2	k	t-stat	5% cv	10% cv	lags
BGD	IND	0	-2.569	-3.04	-2.76	3
BGD	LKA	0	-1.355	-3.04	-2.76	0
BGD	NPL	0	-1.705	-3.04	-2.76	3
BGD	PAK	1	-2.212	-4.11	-3.83	0
IND	LKA	1	-3.656	-4.11	-3.83	0
IND	NPL	1	-4.714	-4.11	-3.83	0
IND	PAK	1	-2.225	-4.11	-3.83	0
LKA	NPL	0	-1.740	-3.04	-2.76	1
LKA	PAK	0	-1.493	-3.04	-2.76	2
NPL	PAK	1	-4.762	-4.11	-3.83	4

Note: critical values are extrapolated from Enders and Lee (2011, table 1) and Schmidt & Phillips (1992, table 1a)

For an extended, and more formal, search for convergence clubs within SAARC5 we use the method of Phillips and Sul (2007, 2009). Their "log-t test" formalises the concept of σ-convergence by testing for long-run decline in the cross-sectional variance of log per capita GDP within a group of countries. The theoretical model underpinning the log-t test is a two-factor growth model in which each country's development follows from the combination of a common growth path, shared by the whole group, with that country's idiosyncratic factor. Convergence is defined as the long-run vanishing to zero of each country's idiosyncratic factor. The ratio of each country's log per capita GDP to the group average is called a

"transition factor" and a tendency for the cross-sectional variance of the transition factors to decline with time is taken as evidence of convergence. The log-t test is obtained from a regression, using a trimmed sample and HAC-robust standard errors, in which the regressand is based on the negative log of the cross-sectional variance series and the regressor is the logarithm of a linear time trend; a significantly negative coefficient for this regressor is taken as evidence of divergence. We find that applying the log-t test to the SAARC5 group yields a negative t-statistic with a p-value below 0.0001, rejecting convergence for the full group.

Having discovered that the evidence is against convergence for SAARC5, the question remains whether there might be some convergent sub-groups of member countries. Phillips & Sul propose a search strategy that repeatedly applies the log-t test to sub-groups of countries selected according to a particular decision rule. They suggest that this algorithm has high probability of discovering all convergence clubs amongst the many possible sub-group permutations. With the number of cross-section units as small as is the case here, it is computationally feasible to simply inspect all possible sub-groups, applying the log-t test to each. We find that the t-statistic in these log-t regressions is significantly negative, indicating divergence, in most cases, with p-values that are zero to four decimal places. Table 8 shows those cases where the p-value is greater than this.

Table 8: log-t testing of SAARC5 sub-groups

sub-group members	t-statistic	one-tailed p-value
IND PAK	1.154	n.a.
BGD PAK	-0.626	0.2672
IND LKA	-1.834	0.0369
NPL PAK	-2.962	0.0025
BGD NPL	-3.203	0.0013
BGD NPL PAK	-3.401	0.0007

NOTE: all other sub-groups have smaller p-values

The Phillips and Sul log-t test identifies India and Pakistan as a convergent sub-group. Figure 1 shows that this is because India caught up with Pakistan in terms of per capita GDP at the start of the current century. Moreover, India appears to since be steadily increasing its lead, and the log-t test is not always able to distinguish instances of such "overtaking" from "converging". If we therefore choose to discount the possibility of India and Pakistan being a convergence club then the next most likely candidates are Pakistan and Bangladesh, followed by India and Sri Lanka. If Nepal must be assigned to one of these two groups then Table 8 shows that Nepal's growth path has more affinity with Pakistan and Bangladesh than with

India and Sri Lanka. Given that Sri Lanka and India are the two highest ranked SAARC members in terms of per capita GDP during recent years, convergence testing with the log-t test thus points to the possibility that the SAARC group is exhibiting "core and periphery" / "twin track" development, arguably reminiscent of the current situation in the EU.

5. Conclusion

We have used unit root tests to assess stochastic convergence in, as a necessary condition for growth convergence, amongst the principal member countries of the South Asian Association for Regional Cooperation (SAARC). Since inappropriate restrictions on the deterministic components of the test equations can lead to under-rejection of the unit root hypothesis, we have used a sequence of unit root tests that place increasingly weaker restrictions on the nature of any deterministic trend in the gap between each country's log per capita income and the group aggregate. We find only weak evidence for stochastic convergence and then only for a subset of member countries, thence concluding that these countries are not a convergent group. This finding raises doubts regarding the current feasibility of SAARC's announced intention of eventual full monetary union.

Noting that all of the countries considered here show some evidence of bilateral stochastic convergence with at least one other SAARC member, we have used the Phillips and Sul (2007, 2009) log-t test to identify convergent sub-groups. We conclude that, by this criterion, there is some evidence of twin-track development paths within SAARC, with India and Sri Lanka as a convergent core group enjoying a relatively favourable growth path, and Bangladesh, Nepal and Pakistan excluded from this convergence club.

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